


Re: Information and SOPs for gamma scanning instruments   
CharlesA Hooper to: Dan Gravatt

07/06/2012 01:41 PM

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Dan Gravatt

Chuck, I'm putting together a QAPP for the upco...

07/05/2012 10:15:50 AM

From: Dan Gravatt/R7/USEPA/US  
To: CharlesA Hooper/R7/USEPA/US@EPA  
Date: 07/05/2012 10:15 AM  
Subject: Information and SOPs for gamma scanning instruments

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Chuck,

I'm putting together a QAPP for the upcoming gamma scan work. Some questions came up which I hope you can help me with:

- Are there SOPs for the "RAT" (Ludlum model 2221 with 3x3" NaI TI detector, in a baby carriage) and/or the down-hole probe and its instrument? If so, I need to append them to my QAPP. There are Equipment Operating Guides with each instrument, but I don't recall if there's one specific for a RAT setup. Here are a few examples, Mark Zipf can be contacted with specifics.



Ludlum Scaler Ratemeter - Model 2241-3.pdf Ludlum Scaler\_Ratemeter Model 2241-3.pdf

- What is the model number on the down-hole probe and the instrument the down-hole probe will be connected to? Previous down-hole scans used a Ludlum 2200 or 2350 with an energy threshold of 100 keV and an open energy window - I hope that means something to you. The detector is a 44-62 and the meter base will likely be a 2241-3 (also Ludlum). I don't think we have the 2200 or 2350 where you can have some control over the energy range, but with an open energy window your not screening out any low energy stuff anyway so this should work. I have asked Mark to get it calibrated with one of the extra 2241-3 we have to counts per minute or counts per second.

- What's a reasonable speed to move the RAT across the surface, and a reasonable distance between the sensor and the ground surface? I assume we will mount it on one of the UTVs for this work due to the large area. Basically the meter acts like a data logger and collects data every two seconds, so walking speed is usually good enough resolution for a nice density of points. Typical distance is about 1 foot off the ground, that's going to vary with terrain but you'll want to be as consistent as you can.

- What rad safety or other certifications / training are appropriate for folks doing this work? Most OSCs have biannual advanced radiation safety training, let me know who's doing the work and I can double-check that they've attended last fall's course. They will also need to have their TLD (Thermoluminescent dosimeter, ie dose of record) and an electronic personal dosimeter (EPD).

- What are your thoughts on personnel and equipment (primarily the UTV) decontamination for this work? It'll be needed, preferably dry decon. We've had some procedures for decon of equipment but I think they

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were STARTs. You might ask some of the other OSCs who have had rad sites, Randy, James, and Todd.

- Should you be a signatory on this QAPP? I've never signed them but I have reviewed them.

Thanks,  
Daniel R. Gravatt, PG  
US EPA Region 7 SUPR / MOKS  
901 North 5th Street, Kansas City, KS 66101  
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Principles and integrity are expensive, but they are among the very few things worth having.

# Ludlum Scaler/Ratemeter—Model 2241-3

Ludlum Measurements, Inc., Model 2241-3

Region 7 EPA Equipment #1499

Homeland Security #N/A

RCMS #N/A

October 2008 (Region 7)

NOTE: Guides are to be used by trained personnel only and ARE NOT TO REPLACE THE MANUFACTURER'S OPERATIONS OR TECHNICAL MANUALS. These guides were developed by field personnel for utilization by EPA and its contractors, and are helpful in quick startup and operations. Various limitations have been identified through the experience of the development group. Different makes, models, and updates to this equipment may change the limitations. Calibration, maintenance, and use should be recorded in a logbook. If you have any changes or revisions, please email [kroone.janice@epa.gov](mailto:kroone.janice@epa.gov).



## Uses:

The Model 2241-3 is a portable, microprocessor-based, digital scaler/ratemeter designed for use with scintillation, Geiger-Mueller (G-M), and proportional-type detectors for measurement of ionizing radiation. The instrument is typically used for general-purpose surveying and gross counting. As currently configured with the Ludlum Model 44-62 Gamma Scintillator detector (see Photo 1), the instrument is primarily suited for detecting gamma radiation.

## Quick Start-up and Operation:

### Connecting the Ludlum Model 44-62 Gamma Scintillator Detector:

Connect the detector to the Model 2241-3 using the cable provided with the instrument. For each connection, firmly push the connectors together while twisting clockwise (1/4 turn) until the connection is secured.

**Note:** Because each instrument must be calibrated to a specific detector (or detectors), the detectors are not interchangeable.

**CAUTION:** The rotary selector switch on the Model 2241-3 should be in the OFF position before connecting or disconnecting the cable or detector, as a mild electric shock may occur if contact is made with the center pin of the free connector when the cable is connected to the instrument (if it is turned on).



Photo 1

### Operational Check:

To ensure that the survey meter is functioning properly, perform an operational check as follows before using the instrument:

1. Move the detector selector switch on the 2241-3 to "DET 2" (see Photo 2).
2. Place the SCA/RATE (scaler/ratemeter) toggle switch in the RATE position. The display will go through an initialization process, described in Steps 3 to 5.
3. The Liquid Crystal Display (LCD) should display the firmware number in the format P-XX, where "XX" is the firmware number. Smaller digits at the lower right-hand corner of the display indicate the firmware version.
4. The minimum displayable value will be shown; when switched to SCA, a single "0" should be displayed.
5. The display will auto range to the current radiation level. Background readings with the Model 44-62 detector are typically 8-15 microroentgens per hour ( $\mu\text{R/hr}$ ).
6. Read the check source mounted on the side of the 2241-3 with the detector to check for a positive response on the LCD display.
7. Switch the AUD ON/OFF switch to the ON position and confirm that audible clicks are produced and increase in frequency as the detector nears the check source. The clicks will be silent in the OFF position; however, the audible alarm condition will still be active.
8. Move the detector near the check source to check that preset alert and higher alarm conditions are indicated on the display and the alarm is activated. (Note: This may have already occurred during Step 6 or 7.) Depress the RESET switch to acknowledge (and silence) the alarm. Move the detector away from the check source and depress RESET again to reset the alarm and alert indicators. If an alarm condition is not present (but above the preset alert level), depressing the RESET switch will reset the alert condition and zero the ratemeter.
9. Place the SCA/RATE switch in the SCA position. Depress the count switch button at the front end of the carrying handle to start the count cycle. The word "COUNTING" should be displayed on the LCD screen; it will disappear at the end of the predetermined count period. If a scaler alarm occurs, press RESET to acknowledge (and silence) the alarm; however, the count switch button must be depressed to clear the alarm indicator on the display and reset the count cycle.
10. Depress and release the LIGHT switch to verify that the backlight works. The light will automatically go off after a few seconds.
11. Select the desired F/S (see Additional Operation Information), AUD ON/OFF, and RATE/SCA settings, and proceed to use the instrument (no warm-up time is required).

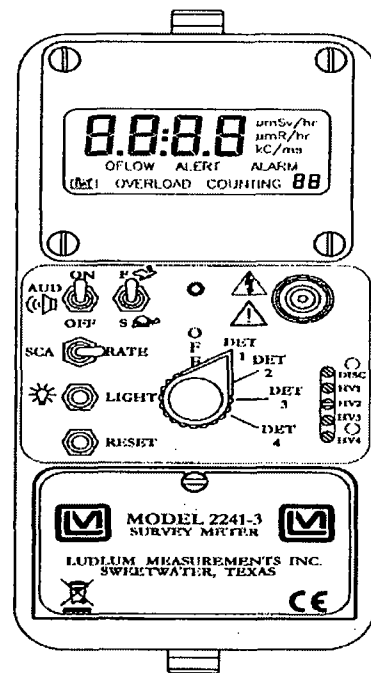


Photo 2



### **Calibration Procedures:**

Annual calibration by Ludlum Measurements Inc., is recommended. Recalibration should also be performed after any maintenance or adjustments have occurred. Recalibration normally is not necessary after battery and cable replacements or exterior cleanings. No field calibration of the instrument is required.

### **Additional Operation Information:**

- The instrument is suitable for indoor and outdoor use over a temperature range of -20° C to 50° C, and at a relative humidity of less than 95% (non-condensing).
- The “S” position (slow) is normally used when displaying low numbers, requiring a stable display. The “F” position (fast) is generally used when high count levels are encountered.

### **Applications:**

The primary use for the Model 2241-3 and Model 44-62 detector is general purpose surveying and gross counting for gamma radiation. In addition, the small diameter of the 44-62 detector enables it to be used for downhole applications.

### **Limitations:**

- In order to use a certain detector, for example the Model 44-62, the detector must be configured with the 2241-3 to work properly.
- The instrument operates on two D-cell batteries, which will discharge during use. Carrying extra batteries with the unit at all times is recommended.
- The current configuration of the 2241-3 with the Model 44-62 detector will detect only gamma radiation; neither alpha nor beta radiation will be detected.

### **Battery Use:**

To install the two D-cell batteries, turn the rotary detector selector switch to the OFF position. Open the battery lid by turning the thumb screw a quarter turn counter-clockwise. Install the batteries into the compartment, taking notice of the (+) and (-) markings inside the battery door.

**Note:** Never store the instrument over 30 days without removing the batteries. Although this instrument will operate at very high ambient temperatures, battery seal failure can occur at temperatures above 100°F.

### **Main Inventory of Items and Accessories:**

- Model 2241-3 instrument
- Cable for connecting detector
- Model 44-62 Gamma Scintillator detector

## Replacement of Auxiliary Equipment and Supplies:

No routine replacement of auxiliary equipment or supplies (other than batteries) is required.

## Parts List:

Part Type	Part Name	Part Description	Quantity
Battery	Instrument batteries	Standard D-cell batteries	2
Cable	Standard Ludlum "C" cable	5' cable w/ "C" connections on both ends	1
Detector	Model 44-62 Gamma Scintillator	6 3/4" long, 3/4" diameter tan probe	1
Instruction Manual	Instruction manual for Model 2241-3 Survey Meter	67-page 11" x 8 1/2" manual	1
Instruction Manual	Instruction manual for Model 44-62 Gamma Scintillator	7-page 8 1/2" x 5 1/2" manual	1

## Routine Maintenance:

Frequency	Action	Manual Reference	Performed By
Before Each Use	Perform an operational check	Page 2-2	OSC/START
Annually	Factory recalibration and certification	Page 6-1	Ludlum Measurements Inc.
After Each Use	Perform decontamination <sup>1</sup>	Page 6-1	OSC/START

Notes:

<sup>1</sup> The Model 2241-3 may be externally cleaned with a damp cloth (using only water as the wetting agent). Do not immerse in any liquid. Observe the following precautions when cleaning:

1. Turn the instrument OFF and remove the batteries.
2. Allow the instrument to sit for 1 minute before performing any external cleaning or accessing internal components for maintenance.

## Shipping Requirements:

Proper decontamination should be performed prior to shipping the instrument and accessories. To return the instrument for repair or calibration, provide sufficient packing material and labeling for safe handling. Include detector(s) and related cable(s) for calibration. Include brief information as to the reason for return, as well as the following return shipping information:

- Return shipping address
- Customer name and contact
- Telephone number

**Contact Information (Technical Support):**

Ludlum Measurements, Inc.  
501 Oak St, P.O. Box 810  
Sweetwater, TX 79556  
Telephone: 325-235-5494  
Fax: 325-235-4672  
Website: <http://www.ludlums.com>  
E-mail: [ludlum@ludlums.com](mailto:ludlum@ludlums.com)

**References:**

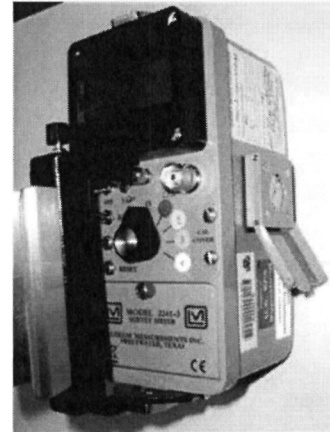
Ludlum Measurements, Inc. Instruction Manual for Ludlum Model 44-62 Gamma Scintillator.  
July 1999. 7 pages.

Ludlum Measurements, Inc. Instruction Manual for Ludlum Model 2241-3 Survey Meter. July 2007.  
67 pages.

# Ludlum Scaler/Ratemeter—Model 2241-3

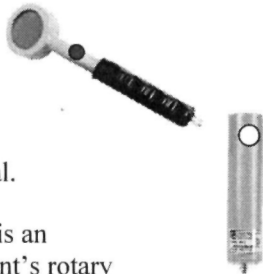


Ludlum Measurements, Inc., Model 2241-3  
Region 7 EPA Equipment #1596, #1597, & #1598  
Homeland Security #N/A  
RCMS #10973  
November 2009 (Region 7)

NOTE: Guides are to be used by trained personnel only and ARE NOT TO REPLACE THE MANUFACTURER'S OPERATIONS OR TECHNICAL MANUALS. These guides were developed by field personnel for utilization by EPA and its contractors, and are helpful in quick startup and operations. Various limitations have been identified through the experience of the development group. Different makes, models, and updates to this equipment may change the limitations. Calibration, maintenance, and use should be recorded in a logbook. If you have any changes or revisions, please email [kroone.janice@epa.gov](mailto:kroone.janice@epa.gov).



## Uses:

The Model 2241-3 is a portable, microprocessor-based, digital scaler/ratemeter designed for use with scintillation, Geiger-Mueller (G-M), and proportional-type detectors for measurement of ionizing radiation. The instrument is typically used for general-purpose surveying and gross counting of alpha, beta, and gamma radiation. Four probes (detectors) are supplied with the Model 2241-3:

1. Model 44-9 Geiger-Mueller (G-M) "pancake probe" is approximately 11" long, detects **alpha and beta** radiation (some gamma radiation also) and is used with the instrument's rotary selector switch pointed toward the one (first) position (red dot)—see photos on this page. The pancake probe is mostly used for contamination control by carefully surveying personnel and equipment for loose radioactive material.
2. Model 44-2 "sodium iodide" (NaI) low level **gamma** scintillator detector is an approximately 6 1/2" X 2" round tan probe which is used with the instrument's rotary selector switch pointed toward the two position (yellow dot). The sodium iodide is a high efficiency gamma detector that is useful for finding lost sources. Often a grid pattern survey is utilized for this type of detector since the audible has a high frequency of counts even at normal background levels. The sodium iodide detector is a low range instrument.
3. Model 133-8 **gamma** G-M detector is about 4" X 7/8" with a metallic finish and is used with the instrument's rotary selector switch turned toward the third position (blue dot). This high range instrument is used in the R/hr exposure range.
4. Model 44-38 is an energy compensated "side window" **beta-gamma** G-M round probe that is approximately 6" X 1" and metallic in finish. It is used in the fourth position (white dot) on the instrument's rotary selector switch. This detector includes a rotary shield, which when opened, allows the detection of beta radiation for energies above about 200 kiloelectron volts (keV). The shield must be closed for proper gamma radiation detection. The side

window probe is a broad range instrument that is most commonly used for general surveys. The side window can be closed or open to account for just gamma or the combination of gamma and beta radiation, respectively.

### Quick Start-up and Operation:

#### Connecting a detector to the Ludlum Model 2241-3 Meter:

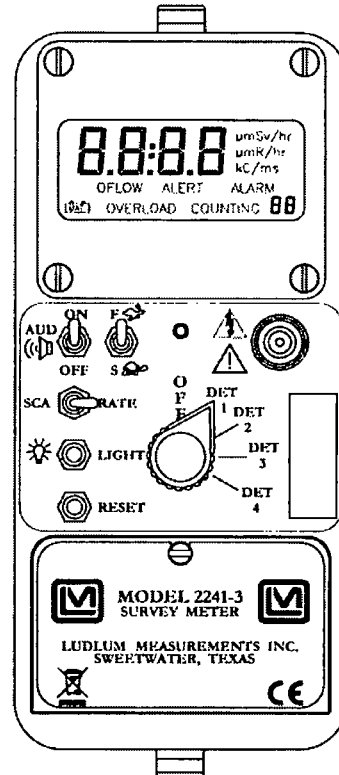
**CAUTION:** The rotary selector switch on the Model 2241-3 should be in the **OFF** position before connecting or disconnecting the cable or detectors. Otherwise, a mild electric shock may occur if contact is made with the center pin of the free connector.

Connect the detectors to the Model 2241-3 using the “C” series cable provided with the instrument. For each connection, firmly push the connectors together while twisting clockwise (1/4 turn) until the connection is secured. Because each instrument must be calibrated to a specific detector (or detectors), the detectors are not interchangeable from one unit to another.

#### Operational Check:

To ensure that the survey meter is functioning properly, perform an operational check as follows before using the instrument:

1. Place two D-cell batteries in the instrument.
2. Connect one of the four detectors to the instrument using the cable provided. Be sure to turn the unit off before changing detectors.
3. Move the detector selector switch on the 2241-3 to the appropriate detector position (as discussed above), depending on which probe you have attached to the instrument. Note the check source and calibration sticker on the side of the instrument. It provides response check values for each detector against the check source except for the high range detector Model 133-8.
4. Place the SCA/RATE (scaler/ratemeter) toggle switch in the RATE position. The display will go through a brief initialization process.
5. The display will auto range to the current radiation level. Check for an appropriate background readings as indicated below:
  - a. Model 44-2 detector – typically 1,400 to 2,600 counts per minute (cpm) or 8 to 15 microRoentgens per hour ( $\mu\text{R/hr}$ ).
  - b. Model 44-9 detector – typically 25 to 50 cpm or 8 to 15  $\mu\text{R/hr}$ .
  - c. Model 44-38 detector – typically 8 to 15  $\mu\text{R/hr}$ .



6. **Conduct a response check by opening the check source door and placing the end of the detector in contact with the check source.** The value indicated on the meter should correspond to  $\pm 20\%$  of the value listed on the calibration sticker on the side of the instrument for the specific detector. If the response check or background reading is not within the appropriate aforementioned range, the meter should be placed out of service. Holding the detector in a consistent manner with each reading will help produce more consistent readings.

**NOTE:** The sodium iodide detector is placed perpendicular against the check source at its end; the pancake probe requires removal of the red cap and then placing the detector window against the check source; and the side window detector requires an open window reading with the slots facing toward the check source while performing the response check.

7. Switch the AUD ON/OFF switch to the ON position and confirm that audible clicks are produced and increase in frequency as the detector nears the check source. The clicks will be silent in the OFF position; however, the audible alarm condition will still be active (i.e., can still be heard).
8. If a scaler reading is desired, place the SCA/RATE switch in the SCA position. Note that this switch must be lifted upwards to move it. When switching to SCA, a single "0" should be displayed on the Liquid Crystal Display (LCD). Depress the count switch button at the front end of the carrying handle to start the count cycle. The word "COUNTING" should be displayed on the LCD; it will disappear at the end of the predetermined count period. The predetermined count time can be changed; however, this requires adjusting the SCALER TIME for the individual detector that is accessed by unlatching the meter housing.
9. If the ratemeter alarm activates, depress the RESET button to acknowledge (and silence) the alarm and/or alert indicators.
10. Depress and release the LIGHT switch to verify that the backlight works. The light will automatically go off after a few seconds.
11. Select the desired F/S (see Additional Operation Information), AUD ON/OFF, and RATE/SCA settings, and proceed to use the instrument (no warm-up time is required).

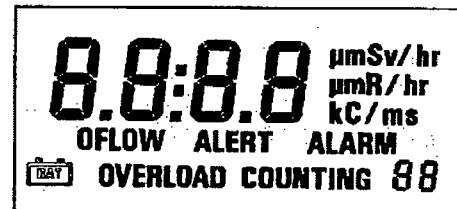
### **Calibration Procedures:**

Annual calibration by Ludlum Measurements Inc., is recommended. Recalibration should also be performed after any maintenance or adjustments have occurred. Recalibration normally is not necessary after battery and cable replacements or exterior cleanings. No field calibration of the instrument is required.

### **Additional Operation Information:**

- The instrument is suitable for indoor and outdoor use over a temperature range of -20 to 50 degrees Celsius ( $^{\circ}\text{C}$ ), and at a relative humidity of less than 95% (non-condensing).
- The "F"/"S" (Fast/Slow) toggle switch selects either a fast or slow counting response time of the displayed reading. Generally a slow response time is used when a stationary and precise measurement is required. A fast response time is used for most other measurements.

- The scaler measures in counts per preselected units of time—usually one minute. Using the ratemeter setting and the check source, the pancake probe reads in counts per minute (cpm) or in 1,000 counts per minute (Kcpm), whereas the other detectors read in microRoentgens per hour ( $\mu\text{R/hr}$ ) or milliRoentgens per hour (mR/hr). The appropriate multiplier automatically changes as needed. The ratemeter mode is for general survey purposes, whereas the scaler mode has more specific purposes, beyond the scope of this document.
- When the instrument is first turned on, all items on its liquid crystal display (LCD) light up. A few seconds is required, while the screen initializes, before the first reading can be taken.
- If an alert threshold is achieved (only on the ratemeter mode), the word “Alert” appears on the LCD. If detectible radiation increases to the alarm threshold, the word “Alarm” appears on the LCD and an alarm sounds regardless of whether the audio is turned on or not. These alarms are factory set, but can be changed—see the manufacturer’s product manual. Push the reset button to acknowledge and silence the alert/alarm.
- Two other alarm settings can occur: (1) “OFLOW” occurs when the radiation count exceeds 100,000 counts per second (CPS) or if the dead time is greater than 75%; (2) “Overload” occurs when radiation intensity is above the instrument’s maximum operating capacity.



### Applications:

The primary use for the Model 2241-3 and its detectors is for general purpose surveying and gross counting of alpha, beta, and gamma radiation contamination. Proper readings occur with relative humidity less than about 95 percent—i.e., the instrument should not be used in the rain or snow.

### Limitations:

- In order to use a certain detector, the detector must be configured with the 2241-3 to work properly. Do not swap detectors from one unit to another.
- The instrument operates on two D-cell batteries. Carrying extra batteries with the unit at all times is recommended.
- Instrument readings are not equivalent to dose—other factors (e.g., duration of exposure, type of radiation) are involved in determining dose.

### Battery Use:

To install the two D-cell batteries, turn the rotary detector selector switch to the OFF position. Open the battery lid by turning the thumb screw a quarter turn counter-clockwise. Install the batteries into the compartment, taking note of the (+) and (-) markings inside the battery door. Battery condition is shown via an icon in the LCD.

**Note:** Never store the instrument over 30 days without removing the batteries. Although this instrument

will operate at very high ambient temperatures, battery seal failure can occur at temperatures above 100 degrees Fahrenheit (°F).

#### **Main Inventory of Items and Accessories:**

- Model 2241-3 instrument
- C-series cable for connecting detectors to the Model 2241-3 instrument
- Model 44-2 gamma scintillator detector
- Model 44-9 pancake detector for alpha and beta radiation
- Model 44-38 energy-compensated beta-gamma Geiger Mueller detector
- Model 133-8 gamma detector
- Check source (attached to side of instrument)
- D-cell batteries (minimum of two; carry four for best results)

#### **Replacement of Auxiliary Equipment and Supplies:**

No routine replacement of auxiliary equipment or supplies (other than batteries) is required.

#### **Parts List:**

<b>Part Type</b>	<b>Part Name</b>	<b>Part Description</b>
Cable	Instrument Cable	36" black C-series cable
Cap	Caplug	2 7/8" red plastic cap for pancake probe
Case	Instrument Case	Hardigg iM2300 Storm case
Check Source	Cesium-137 1.0 $\mu$ Ci Check Source	1" yellow disk
Detector	Model 133-8 Gamma Detector	4" x 7/8" diameter silver-colored metal tube w/ C-series connection
Detector	Model 44-2 Gamma Scintillator	6 1/2" x 2" diameter tan-colored metal tube w/ C-series connector
Detector	Model 44-38 Energy Compensated Beta-Gamma (G-M) Detector	6" x 1" diameter silver-colored metal tube w/ C-series connection
Detector	Model 44-9 Alpha-Beta-Gamma Detector	11" pancake probe
Instruction Manual	Ludlum Model 133-8 Gamma Detector Instruction Manual	8 page 9" x 5" manual; Feb 2008
Instruction Manual	Ludlum Model 2241-3 Survey Meter Instruction Manual	50 page 8 1/2" x 11" manual; July 2007
Instruction Manual	Ludlum Model 44-2 Gamma Scintillator Instruction Manual	12 page 9" x 5" manual; Oct 2007
Instruction Manual	Ludlum Model 44-38 Beta-Gamma Detector Instruction Manual	10 page 9" x 5" manual; Oct 2007
Instruction Manual	Ludlum Model 44-9 Alpha-Beta-Gamma Detector Instruction Manual	10 page 9" x 5" manual; May 2007
Power Supply	Battery	Two D-cell batteries
Strap	Shoulder Strap	Black fabric shoulder strap

Note:  $\mu$ Ci - microCuries



### **Routine Maintenance:**

<b>Frequency</b>	<b>Action</b>	<b>Manual Reference</b>	<b>Performed By</b>
Before Each Use	Operational check	Page 2-2	OSC/START
After Each Use	Decontamination <sup>1</sup>	Page 6-1	OSC/START
Monthly	Functional Test/Battery Check <sup>2</sup>	None	START
Annually	Factory recalibration and certification	Page 6-1	Ludlum Measurements Inc.

Notes:

<sup>1</sup> The Model 2241-3 may be externally cleaned with a damp cloth (using only water as the wetting agent). Do not immerse in any liquid. Observe the following precautions when cleaning:

- a. Turn the instrument OFF and remove the batteries.
- b. After use allow the instrument to sit for 1 minute before performing any external cleaning or accessing internal components for maintenance.

<sup>2</sup> Additionally, check that all parts are present.

OSC On-scene coordinator

START Superfund Technical and Response Team

### **Shipping Requirements:**

Proper decontamination should be performed prior to shipping the instrument and accessories. To return the instrument for repair or calibration, provide sufficient packing material and labeling for safe handling. Include detector(s) and related cable(s) for calibration. Include brief information as to the reason for return, as well as the return shipping information. Be sure to keep the Certificate of Calibration with the unit at all times. This is kept under the foam within the top portion of the case.

### **Contact Information (Technical Support):**

Ludlum Measurements, Inc.  
501 Oak St, P.O. Box 810  
Sweetwater, TX 79556  
Telephone: 325-235-5494  
Fax: 325-235-4672  
Website: <http://www.ludlums.com>  
E-mail: [ludlum@ludlums.com](mailto:ludlum@ludlums.com)

### **References:**

Ludlum Measurements, Inc. Instruction Manual for Ludlum Model 44-2 Gamma Scintillator. October 2007. 12 pages.

Ludlum Measurements, Inc. Instruction Manual for Ludlum Model 44-9 Alpha, Beta, Gamma Detector. May 2007. 10 pages.

Ludlum Measurements, Inc. Instruction Manual for Ludlum Model 44-38 Beta-Gamma Detector. October 2007. 10 pages.

Ludlum Measurements, Inc. Instruction Manual for Ludlum Model 133-8 Gamma Detector. February 2008 (Serial Number 158103 and Succeeding Serial Numbers). 8 pages.

Ludlum Measurements, Inc. Instruction Manual for Ludlum Model 2241-3 Survey Meter. July 2007. 50 pages.